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Pressure Effect on Phase Behavior of Surfactant System

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Introduction

It is expected that many mature oil reservoirs still have more than 50 % remaining crude oil trapped, which cannot be recovered by primary nor secondary recovery techniques. As oil recovery potential is still expected for these reservoirs Enhanced Oil Recovery (EOR) is introduced and in this work by surfactant flooding. Surfactant flooding is basically a technique where appropriate surfactants are injected into the reservoir to reduce the interfacial tension (IFT) between crude oil and water.

This work handles the present phase behavior of surfactant-oil-brine systems at reservoir conditions, which is at elevated pressures and temperatures. From literature studies it is understood that mixed surfactant systems are most commonly used for surfactant flooding as this result in the most efficient increase in oil recovery. However, when mixed surfactants are used this raises new obstacles, as the surfactant blend will undergo chromatographic separation down through the reservoir and thereby change composition during the flooding operation, which finally makes it difficult to predict the actual recovery outcome. Therefore it is preferable with simple surfactant systems and if possible potential single component surfactant systems are the most optimal solution for this oil recovery technique. As this approach is an expensive recovery method, as it will be large amounts of surfactant (or chemicals) required for the operation, this technique must be well understood before integrated into the oil plants.

Phase Behavior

This work considers the understanding of the effect of pressure on the phase behavior of the brine/surfactant/oil system. For this study a model system is chosen; Water in Sodium Chloride/Sodium Dodecyl Sulphate (SDS)/1-Butanol/Heptane, which have been studied previously at room temperature and at atmospheric pressure [2]. The general understanding of pressure

effect on such systems is that pressure does not have an effect on the phase behavior. However, this is debatable according to literature.

This work is entirely experimental, where the model system is examined in high pressure equipment using a DBR JEFRI PVT cell, which allows a wide range of different temperatures and pressures. Furthermore the system can be observed through a window in the equipment and thus the increase or decrease in phase volumes and number of phases can be followed.

The experimental work is carried out at temperatures from 40-50°C and at pressures from 1 to 400 bars. The initial and final composition of the system is given in table 1. During process the heptanes is added to the system, which is why composition change during experimental work.

Table 1. Initial and final composition of brine/surfactant/oil-system in wt%

water	NaCl	SDS	1-butanol	heptane
0.616	0.043	0.025	0.051	0.265
0.532	0.037	0.022	0.044	0.365

The present system starts as a 3 phase system both in its initial composition and at the final. However, it is observed that as pressure is increased the system goes towards and 2 phase system when equilibrated. The system does also show sensitivity to temperature increase as would be expected, where an increase in temperature forces the system to a 2 phase system.

Conclusion

The aim is to study the phase behavior of the present model system. The model system has already been studied and room temperature and this work examine the system at elevated pressures and temperatures.

As the pressures range is 1-400 bars, which is common at reservoir conditions, this is highly relevant to oil recovery processes and surfactant flooding.

References

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